input. Their method involves separating outlay on capital services into price and quantity components using an accounting imputation. The method of imputation is based on the correspondence between asset prices and service prices implied by the equality between the value of an asset and the discounted value of its services. Christensen and Jorgenson (1970), (1973a), (1973b) integrated their method for measuring real capital input into a complete accounting system for the private sector of a national economy.

In this paper we follow the methods of Christensen and Jorgenson in developing estimates of real product and real factor input for the private sector of the Canadian economy. We employ our estimates to study productivity change in the private sector of the Canadian economy for the postwar period. We present estimates of changes in manhour productivity and total factor productivity. We also show the relationship between manhour and total factor productivity.

Our estimates averaged over the period 1947-1973 yield the following conclusions for the private sector of the Canadian economy: The economy grew at a rate of 5.1% per year. Almost two-thirds of this growth can be attributed to increases in real factor input; 0.9% has been due to growth of labor input, 2.5% has been due to growth of capital input, while 1.8% has been due to increases in total factor productivity. Manhour productivity has increased at 4.1% per year. Of this total 1.8% resulted from increases in total factor productivity, 0.3% from increased quality of the labor force, 0.6% from increased quality of the capital stock, and 1.5% from increases in the capital-labor ratio.

2. The Production Account in Current Prices

Our production account is for the private domestic sector of the Canadian economy. The general government is excluded. The "rest of world" sector of the Canadian economy is also excluded. Thus the production account covers only private business enterprises, government enterprises, and households.

Our concepts of revenue and outlay are from the producer point of view. The value of output is net of taxes on output but the value of input is gross of taxes on input. Thus we divide indirect business taxes into two categories. We exclude from the value of production all indirect business taxes which are viewed as charges against revenue, such as excise or sales taxes. But we include indirect business taxes charged to the producer as part of outlay in obtaining services from productive factors, such as property taxes. In effect we increase factor cost by indirect business taxes related to the level of input of productive factors. We treat government subsidies to the business sector as negative indirect business taxes charged against revenue. Thus we add subsidies to arrive at the value of output from the producer point of view.

In the Canadian national income and product accounts an estimate of the services of owner-occupied housing is included in the product of the private sector. The flow of capital services resulting from investment in housing by owner-occupiers is not, however, recorded in market transactions. The value of this service flow must be imputed from data on

rental values for tenant-occupied housing. In the Canadian accounts the treatment of capital services from consumer durables is not symmetrical with that of housing. Purchases of consumer durables are treated as part of personal consumption expenditures rather than investment, and the service flow from these durables, unlike housing services, is not included in GNP.

We treat the services of owner-utilized consumer durables symmetrically with the services of owner-occupied housing. Purchases of new consumer durables are included in private investment, rather than consumption. This change from the conventions of the Canadian national income and product accounts leaves the value of total product unaltered. We then impute the value of services of consumer durables using the cost of capital implicit in the service flow for owner-occupied housing. We add the resulting service flow to the product of the private sector.

Following standard practice, the Canadian national income and product accounts contain two estimates of GNP -- one from the gross product point of view and one from the gross factor income point of view. A "residual error of estimate" appears in the accounts to reconcile the two estimates. In the Canadian accounts the official estimate of GNP is the arithmetic mean of the estimates constructed from the gross product and gross income point of view.[1] Thus it is implicitly assumed that the discrepancy is due to errors of equal magnitude in measuring GNP from the two different

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[1]See Tables 1 and 2 of the National Income and Expenditure Accounts.

points of view. In order that deliveries to final demand sum up to GNP we use the estimate of GNP from the product point of view. We alter the estimate of GNP from the factor income point of view to reconcile it with the estimate from the product point of view. We achieve this reconciliation by adjusting property compensation by the entire difference between the two GNP estimates (twice the residual error of estimate). We assign the difference to property compensation in the belief that labor compensation is measured more accurately then property compensation.

Given our definitions of output and input, we may describe more explicitly the measurement of gross private domestic product and gross private domestic factor outlay. The value of gross product is defined as gross national product less GNP originating in general government and rest of world, plus services of consumer durables, less indirect business taxes not related to factor outlay, plus subsidies, less the residual error of estimate. The resulting value of gross private domestic product for the year 1961 is presented in Table 1.

The value of gross private domestic factor outlay is equal to the value of gross private domestic product by definitition. The value of factor

Table 1

Production Account, Gross Private Domestic Product and Factor Outlay, Canada 1961

Millions of Dollars

Product

1.	Gross national product (NIEA[a], table 1)	39,646
2.	- Wages and salaries in general government (NIEA, table 8, lines 2,3,4)	4,072
3.	- Capital consumption allowances in general government (NIEA, table 8, line 14)	531
4.	- Net interest and miscellaneous investment income of general government originating in government (net of government enterprise remittances) (NIEA, Table 48, line 18 minus lines 3, 8, and 13)	171
5.	- Net interest originating in rest of world (NIEA, table 3)	-722
6.	+ Services of consumer durables (our imputation)	3,511
7.	- Taxes not related to factor outlay (computed from NIEA, table 46, see table 1a below)	3,191
8.	+ Subsidies (NIEA, table 8, line 12)	321
9.	+ Capital assistance (NIEA, table 17, lines 8 and 9)	21
10.	- Residual error of estimate	-142
11.	= Gross private domestic product	36,398

Factor Outlay

1.	National income (NIEA, table 1)	29,783
2.	+ Capital consumption allowances (NIEA, table 1)	4,883
3.	+ Services of consumer durables (our imputation)	3,511
4.	- GNP originating in general government (2 + 3 + 4 above)	4,774
5.	+ Indirect taxes related to factor outlay (see table 1a below)	1,968
6.	+ Capital assistance (9 above)	21
7.	- GNP originating in rest of world (5 above)	-722
8.	- Twice the residual error of estimate	-284
9.	= Gross private domestic factor outlay	36,398

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[a] National Income and Expenditure Accounts, Historical Revision 1926-1973, Statistics Canada.

Table 1a

Indirect Taxes Related to Factor Outlay

1.	Bank and insurance companies	0
2.	Miscellaneous federal indirect taxes	13
3.	Corporation tax (not on profits)	23
4.	Business motor vehicle licenses and permits	109
5.	Other licenses, fees and permits	34
6.	Miscellaneous taxes on natural resources	37
7.	Real property tax	9
8.	Miscellaneous provincial indirect taxes	99
9.	Licenses, fees and permits, local	28
10.	Real and personal property tax	1,487
11.	Miscellaneous local indirect taxes	129
		1,968

Indirect Taxes Not Related to Factor Outlay

1.	Customs Import duties	515
2.	Excise duties	358
3.	Excise taxes	1,302
4.	Amusement tax, provincial	24
5.	Gasoline tax	430
6.	Retail sales tax (including liquor and tobacco)	317
7.	Profits of liquor commissions	188
8.	Amusement tax, local	2
9.	Retail sales tax, local	55
		3,191
Total Indirect Taxes		5,159

outlay is equal to national income plus capital consumption allowances, less government and rest of world GNP, plus services of consumer durables, plus indirect business taxes related to factor outlay, less twice the residual error of estimate. Capital consumption allowances are included since they are part of the outlay for capital services and are included in the rental value of capital services. The resulting value of gross private domestic factor outlay for the year 1961 is given in Table 1. A detailed breakdown of our treatment of Canadian taxes, along with figures for 1961 are presented in Table 1a.

In separating the values of gross product and gross factor outlay into price and quantity components, we find it useful to divide total product among consumption and investment final sales, and changes in business inventories. We divide total factor outlay between capital and labor services. We combine the final sales of durable goods and structures to business and government with final sales of consumer durables and refer to the total as final sales of investment goods.

Our definition of services output includes the services of consumer durables along with services output included in the Canadian accounts. The output of the foreign and general government sectors consists entirely of services, so that we define the output of services by the private domestic sector as services included in gross national product, less the product of foreign and general government sectors, plus the services of consumer durables.

We combine the private domestic sector's output of services with final sales of nondurable goods and refer to the total as final sales of consumption goods.

Our definition of gross domestic business product from the producer point of view excludes indirect business taxes not considered to be charges related to levels of factor inputs. The excluded taxes are mainly sales and excise taxes. Subsidies are netted against these retail business taxes. We refer to the result as "retail taxes less subsidies."

If retail taxes were assessed only on the basis of deliveries to final demand, we could allocate them directly. In fact a substantial portion of sales and excise taxes falls on deliveries to intermediate demand. A completely satisfactory allocation of these taxes would require a detailed input-output analysis. However, the data required to carry out this analysis are unavailable. As a first approximation we have allocated retail taxes less subsidies proportionally to final sales of investment goods and consumption goods and changes in business inventories.

The value of factor outlay in the private domestic sector includes the labor compensation of all employees less compensation of employees in general government, plus the implicit labor compensation of self-employed persons and unpaid family workers. Data for labor compensation of self-employed workers and unpaid family workers was provided by the Productivity Measures Project, Input-Output Division, Statistics Canada.[2] Data for labor compensation of employees is taken from the National Income and Expenditure Accounts.

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[2]We are indebted to Mr. A. B. McCormick and Ms. A. Browley for providing and permitting us to use this unpublished data and additional unpublished labor data discussed below.

All private domestic factor outlay not allocated to labor is allocated to capital. Specifically, the value of outlay on capital services includes the following: property income of self-employed persons, profits, rentals, and interest; capital consumption allowances; business transfer payments; indirect business taxes that are part of the outlay on productive factors, such as motor vehicle licenses and property taxes; and the imputed value of the services of consumer durables. Gross private domestic product and factor outlay in current prices for 1947-1973 are given in Table 2.

Total product in Table 2 is broken down into final sales of investment goods, final sales of consumption goods, and changes in business inventories. Total product is also divided between labor compensation and property compensation.

3. Price and Quantity Index Numbers for Total Product

We follow Christensen and Jorgenson (1970) in using discrete approximations to the Divisia Index to construct aggregate quantity indexes. We define the rate of growth of the quantity aggregate q_t as

$$\log q_t - \log q_{t-1} = \Sigma \bar{W}_{it} [\log q_{it} - \log q_{i,t-1}]$$

where the weights ($\bar{W}_{it}$) are arithmetic averages of the relative value shares in the two periods

$$\bar{W}_{it} = \frac{1}{2} W_{it} + \frac{1}{2} W_{i,t-1} \; ; \quad W_{it} = \frac{p_{it}q_{it}}{\sum_i p_{it}q_{it}}$$

TABLE 2

GROSS PRIVATE DOMESTIC PRODUCT AND FACTOR OUTLAY, CANADA, 1947-1973 (MILLIONS OF CURRENT DOLLARS)

Year	1. Gross Private Domestic Product	2. Investment Goods Product	3. Consumption Goods Product	4. Inventory Goods Product	5. Labor Compensation	6. Property Compensation
1947	11898.1	3183.2	8405.0	309.9	7785.4	4112.7
1948	14001.4	4095.7	9817.1	88.6	8738.7	5262.7
1949	15337.2	4575.3	10690.1	71.9	9249.9	6087.3
1950	17179.1	5110.6	11561.7	506.8	10090.5	7088.6
1951	19761.7	5580.8	13382.0	799.0	11747.4	8014.3
1952	22458.2	6529.7	15469.3	459.3	12790.0	9668.2
1953	23815.8	6949.7	16314.1	552.0	13670.6	10145.2
1954	23701.9	7060.9	16827.0	-185.9	13796.1	9905.8
1955	26659.1	7967.6	18428.7	262.8	14685.9	11973.2
1956	29579.9	9371.9	19299.7	908.3	16472.7	13107.2
1957	30746.1	10169.1	20420.3	156.8	17745.1	13001.0
1958	32079.1	10137.4	22215.7	-274.1	17944.3	14134.8
1959	34106.6	10324.0	23398.7	383.3	18954.7	15151.9
1960	35826.2	10519.0	24927.5	379.7	19907.9	15918.3
1961	36397.6	10584.5	25705.5	107.6	20125.5	16272.1
1962	38498.5	11365.6	26518.1	614.8	21242.6	17255.9
1963	41697.5	12691.4	28387.2	618.9	22511.2	19186.3
1964	45896.0	14191.2	31195.1	509.6	24332.8	21563.2
1965	50438.8	16060.5	33236.2	1142.1	26895.0	23543.8
1966	55968.2	18417.9	36425.4	1124.8	30108.0	25860.2
1967	58819.7	19267.8	39312.8	238.1	32948.8	25869.9
1968	63094.9	20591.9	41820.9	682.0	35196.8	27898.1
1969	69301.9	22066.2	45893.5	1342.1	39122.1	30179.8
1970	74081.0	23937.2	50047.6	96.3	41919.8	32161.2
1971	81850.6	26274.5	55316.3	259.9	45839.4	36011.2
1972	89554.1	28604.3	60471.0	478.3	50662.3	38891.8
1973	103733.3	33683.7	69094.0	955.6	56475.0	47258.3

The series for q_t itself is then constructed by setting it equal to the current dollar value ($p_t q_t$) in the base year. We use 1961 as the base year for all our quantity indexes.

It is convenient to have the product of price and quantity indexes equal to the value of transactions so that standard accounting identities hold for variables defined as price and quantity index numbers. Accordingly, we construct discrete Divisia price indexes as the value in current prices divided by the discrete Divisia quantity index.

$$p_t = \frac{\sum_i p_{it} q_{it}}{q_t}$$

The resulting price indexes are approximately equal to the Divisia price indexes.

We proceed to construct price and quantity indexes for total product and its components using the Divisia aggregation procedure described above. We first construct separate quantity indexes for purchases of investment goods by the private domestic sector and the government sector. The quantity index of private domestic purchases of investment goods is a Divisia index of (1) nonresidential structures, (2) machinery and equipment, (3) residential structures, and (4) consumer durables.

To construct a quantity index of government purchases of investment goods we first construct a quantity index of structures as a Divisia index of general government purchases of nonresidential structures and general government purchases of residential structures. Then we construct a

quantity index of government purchases of investment goods as a Divisia index of the quantity indexes of producer durables and structures.

We construct a quantity index of domestic final sales of investment goods as a Divisia index of the quantity index of private domestic purchases and the quantity index of government purchases. We construct a quantity index of final sales of investment goods as a sum of the quantity index of domestic final sales and net exports of durable goods.[3]

The quantity index of consumer purchases of goods and services is a Divisia index of (1) nondurable goods, (2) services as defined in the national income accounts, and (3) our imputation for consumer durable services. The quantity index of general government purchases of consumption goods from the business sector is computed by subtracting general government GNP from current government expenditures, both in constant prices.[4] The quantity index of domestic final sales of consumption goods is then constructed as a Divisia index of the quantity indexes for the consumer and general government sectors. We construct a quantity index of final sales of consumption goods by adding real net exports of consumption goods to final domestic sales of

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[3] We sum these quantity indexes rather than use the Divisia index procedure since net exports can be negative. Our Divisia index procedure requires taking logarithms. If a quantity series can take negative values, the indexing procedure is not well-defined.

[4] General government GNP is defined as labor compensation plus capital consumption allowances, plus net interest originating in general government.

consumption goods and subtracting out rest of world GNP.[5]

The quantity index of final sales is constructed as a Divisia quantity index of the quantity indexes of final sales of (1) investment goods, and (2) consumption goods. Changes in business inventories are excluded from this Divisia index because they can take on negative values. Finally, the quantity index of gross private domestic product is constructed by adding the quantity indexes of final sales and changes in business inventories.

Approximate Divisia price indexes corresponding to all of the above-defined quantity indexes are computed by dividing the current dollar values by the quantity indexes. Since the quantity indexes are all constructed such that they equal the current dollar values in 1961, our aggregate price indexes all equal unity in 1961. Price and quantity indexes for gross private domestic product are presented in Table 3.

4. Price and Quantity Index Numbers for Total Factor Input

We would like to use the same Divisia aggregation procedures to construct a quantity index of total input as we did to construct aggregate output. It is possible to construct a Divisia index of the aggregate input of capital

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[5] GNP in rest of world is composed entirely of services: Rest of world GNP is defined as net factor income.

TABLE 3

GROSS PRIVATE DOMESTIC PRODUCT AND FINAL SALES, 1947-1973
(Constant Dollars of 1961)

Year	1. Gross Private Domestic Product, Price Index	2. Gross Private Domestic Product, Quantity Index	3. Consumption Goods Product, Price Index	4. Consumption Goods Product, Quantity Index	5. Investment Goods Product Price Index
1947	.652	18262.6	.658	12767.8	.636
1948	.740	18914.8	.746	13152.8	.720
1949	.768	19971.7	.777	13759.2	.754
1950	.781	22007.0	.780	14817.9	.778
1951	.863	22886.8	.852	15699.2	.875
1952	.897	25038.9	.878	17624.9	.932
1953	.897	26554.3	.884	18450.0	.925
1954	.898	26400.1	.891	18894.3	.915
1955	.926	28802.1	.928	19866.5	.927
1956	.934	31683.7	.915	21084.8	.967
1957	.945	32544.5	.927	22034.0	.985
1958	.961	33370.7	.954	23288.2	.984
1959	.980	34807.6	.968	24178.0	1.003
1960	1.000	35842.8	.994	25077.9	1.014
1961	1.000	36397.6	1.000	25705.5	1.000
1962	.996	38647.5	.995	26648.3	.996
1963	1.021	40823.7	1.021	27800.9	1.022
1964	1.049	43755.4	1.050	29696.3	1.042
1965	1.073	46988.0	1.069	31088.5	1.084
1966	1.115	50199.4	1.109	32844.2	1.132
1967	1.138	51675.1	1.124	34969.0	1.165
1968	1.157	54514.3	1.148	36422.1	1.177
1969	1.221	56773.0	1.225	37462.9	1.219
1970	1.251	59206.7	1.245	40183.0	1.262
1971	1.316	62212.4	1.321	41871.6	1.307
1972	1.381	64835.1	1.393	43403.3	1.358
1973	1.489	69664.9	1.501	46018.4	1.467

TABLE 3 (continued)

6. Investment Goods Product, Quantity Index	7. Inventory Goods Product Price Index	8. Inventory Goods Product, Quantity Index	9. Relative Share of Investment Goods Product
5002.3	.659	490.2	.275
5690.6	1.448	61.2	.294
6065.3	.517	139.1	.300
6571.5	.832	609.3	.307
6379.5	.994	804.1	.294
7007.2	1.128	407.1	.297
7515.5	.948	582.4	.299
7715.7	.857	-217.0	.296
8597.0	.805	326.4	.302
9688.2	1.024	886.6	.327
10322.4	1.012	154.9	.332
10303.6	1.159	-236.5	.313
10289.6	1.148	333.9	.306
10370.4	.963	394.1	.297
10584.5	1.000	107.6	.292
11406.4	1.037	592.6	.300
12414.6	1.019	607.5	.309
13615.9	1.150	443.3	.313
14821.7	1.061	1076.7	.326
16275.8	1.050	1071.2	.336
16537.1	1.358	175.3	.329
17501.4	1.153	591.7	.330
18095.5	1.105	1214.9	.325
18964.9	1.598	60.3	.324
20104.7	1.095	237.4	.322
21059.4	1.270	376.5	.321
22953.4	1.351	707.6	.328

services, but there is insufficient data available to carry out a similar procedure for labor services. It would be desirable to distinguish among different categories of labor classified by sex, number of years of schooling, occupation, age and so on. However, earnings data cross-classified with these charactersistics are not available.

Following Jorgenson and Griliches (1967), our quantity index of labor input is a product of total persons employed, average hours worked per person employed, and a quality index based on the educational composition of the male labor force. Our data for average hours per person are from estimates provided by the Productivity Measures Project, Input-Output Division, Statistics Canada. The data for total employment is taken from NIEA and the Bank of Canada Review. Employment in our private sector is arrived at by subtracting out our estimate of general government employment, which is general government labor compensation deflated by the average annual wage in the total economy.

To construct our quality index we used the educational composition of the male labor force from the Canadian Population Census in 1941, 1951, 1961, and 1971. We present the composition for these four years in Table 4. We obtain mean annual earnings for the four educational levels from the Population Census for 1961 and 1971. We present the earnings figures in Table 4. In Table 5 we present our computation of the annual percentage changes in our quality index of labor input. We multiply average hours per man times employment, times the index of educational attainment to obtain our quantity index of labor input. The implicit price of labor services is computed by dividing our estimate of total labor compensation by the quantity index of labor input. In Table 6 we present annual estimates for (1) total employment, (2) the index of educational attainment, (3) average annual hours per person

Table 4

PROPORTION OF MALE LABOR FORCE BY HIGHEST YEAR OF SCHOOL COMPLETED

Years of Schooling	1941	1951	1961	1971	Wages by Educational Attainment 1961	1971
0 - 4	.119	.083	.071	.043	2758	4300
5 - 8	.516	.467	.374	.265	3682	5705
9 - 11	----	----	.311	.344	----	6169
9 - 12	.301	.356	.399	----	4743	----
12 - 13	----	----	.153	.194	----	6822
13+	.063	.094	.156	----	7290	----
Some University	----	----	.043	.077	----	6557
University	----	----	.049	.078	----	12176

Sources:
1) 1941-1951-1961: Dominion Bureau of Statistics, Census of Canada, 1941, 1951, 1961.
2) 1971: Statistics Canada (1971), Census of Canada, Labor Force by Level of Schooling and Sex.
3) Wages, 1961: Dominion Bureau of Statistics (1961), Census of Canada
4) Wages, 1971: Statistics Canada (1971), Census of Canada, Income of Individuals by Schooling, Age and Sex.

Table 5

RELATIVE PRICES*, CHANGES IN THE DISTRIBUTION OF THE LABOUR FORCE, AND INDEXES OF LABOUR-INPUT PER PERSON MALE LABOUR FORCE, 1941-1971

School year completed	p'	Δe	p'	Δe	p'	Δe
	1941-51		1951-61		1961-71	
0 - 4	.653	-.036	.618	-.012	.669	-.028
5 - 8	.872	-.049	.825	-.093	.887	-.109
9 - 11	----	-----	----	-----	.959	.033
9 - 12	1.124	.054	1.063	.043	----	-----
12 - 13	----	-----	----	-----	1.061	.042
13+	1.727	.031	1.633	.062	----	-----
Some University	----	-----	----	-----	1.019	.034
University	----	-----	----	-----	1.893	.029
Growth - 10 years	.0480		.0631		.0495	
Annual Growth	.0047		.0061		.0048	

*The relative prices are computed using the appropriate mean period distribution of the labour force as weights.

TABLE 6

PRIVATE DOMESTIC LABOR INPUT, CANADA, 1947-1973 (CONSTANT DOLLARS of 1961)

Year	1. Private Domestic Persons Engaged (millions)	2. Educational Attainment Per Person (INDEX)	3. Private Domestic Hours Per Person (INDEX)	4. Private Domestic Labor Input Price Index	5. Private Domestic Labor Input Quantity Index
1947	4478936.	.923	1.100	.440	17707.4
1948	4518962.	.928	1.100	.487	17940.7
1949	4610568.	.932	1.091	.507	18242.1
1950	4586244.	.936	1.071	.564	17889.9
1951	4693954.	.941	1.062	.643	18256.4
1952	4742248.	.947	1.057	.693	18457.3
1953	4785056.	.952	1.055	.730	18714.1
1954	4750185.	.958	1.052	.741	18624.1
1955	4842720.	.964	1.043	.775	18941.1
1956	5035964.	.970	1.040	.833	19767.6
1957	5135988.	.976	1.028	.885	20040.7
1958	5059504.	.982	1.021	.909	19742.3
1959	5197606.	.988	1.019	.931	20358.5
1960	5251323.	.994	1.012	.969	20553.3
1961	5172255.	1.000	1.000	1.000	20125.5
1962	5297486.	1.005	1.000	1.026	20712.0
1963	5405157.	1.010	.992	1.068	21072.4
1964	5585157.	1.015	.986	1.119	21742.5
1965	5788843.	1.019	.978	1.198	22453.8
1966	5986896.	1.024	.967	1.305	23064.4
1967	6102988.	1.029	.961	1.402	23496.1
1968	6153883.	1.034	.950	1.495	23536.6
1969	6305133.	1.039	.941	1.630	23999.2
1970	6333820.	1.044	.932	1.749	23973.0
1971	6470970.	1.049	.926	1.874	24464.8
1972	6658148.	1.054	.921	2.015	25148.3
1973	6982711.	1.059	.921	2.131	26506.5

employed, (4) the price index of labor input, and (5) the quantity index of labor input.

The starting point for a quantity index of capital input is a perpetual inventory estimate of the stock of each type of capital, based on past investments in constant prices. At each point of time, the stock of each type of capital is the sum of stocks remaining from past investments of each vintage. Under the assumption that efficiency of capital goods declines geometrically, the rate of replacement, say δ, is a constant. Capital stock at the end of every period may be estimated from investment and capital stock at the beginning of the period:

$$K_t = A_t + (1-\delta)K_{t-1} ,$$

where K_t is end of period capital stock, A_t the quantity of investment, and K_{t-1} the capital stock at the beginning of the period.

For each type of capital included in our accounts, we prepare perpetual inventory estimates of the stock as follows: First, we obtain a benchmark estimate of capital stock from data on national wealth in constant prices. Second, we deflate the investment series to obtain investment in constant prices. Third, we choose an estimate of the rate of replacement. Finally, we estimate capital stock in every period by applying the perpetual inventory method described above.

We construct capital stock estimates for seven distinct classes of assets: (1) nonresidential structures, (2) machinery and equipment, (3) nonfarm inventories, (4) farm inventories, (5) residential structures, (6) consumer durables, and (7) land. All of our investment data in current and constant prices are taken from National Income and

Expenditure Accounts.

We use the deflators implicit in our investment data as estimates of the asset deflators for all assets except for inventories, where the investment deflators are very erratic. We use the wholesale price index for industrial commodities as the nonfarm inventory asset deflator; and we use the wholesale price index for farm products as the farm inventory asset deflator. We assume that the stock of land is constant, which implies zero investment.

We take benchmarks for nonresidential structures and machinery and equipment from Flows and Stocks of Fixed Nonresidential Capital in Canada. Our benchmark for residential structures is taken from The Demand for Durables, Nondurables and Services and the Supply of Labour in Canada, 1946-1969 by T. K. Gussman. The benchmarks for farm and nonfarm inventories have been provided to us by the Gross National Product Division of Statistics Canada.[6] We obtain our consumer durables benchmark from the above study by T. Gussman.

We take the value and quantity index of agricultural land from Output and Input Data from Canadian Agriculture 1926-1970 by Robert S. Danielson. We follow his methodology to estimate values for later years. We then assume the value of non-agricultural land is a given percentage of the value of structures. The percentage is taken from a study of U.S. real estate by Allen Manvel, Trends in the Value of Real Estate and Land, 1956-1966. The value of land is 32.5% of the value of residential structures and 47% of the value of non-residential structures. The total stock of land is assumed to be constant. The price

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[6]We are indebeted to Mr. S. Wells for providng us with these benchmarks.

deflator for all land is then implied by the constant stock of land and the value of agricultural and non-agricultural land.

Flows and Stocks of Fixed Nonresidential Capital in Canada provides replacement rates for detailed types of structure and equipment. We infer average replacement rates from the aggregate stocks of nonresidential structures and machinery and equipment.[7] We take our residential structures rate of replacement from The Canadian Consumer Accounts by Dianne Cummings and Ludwig Meduna. We follow Christensen and Jorgenson (1969) in using .2 as our replacement rate for consumer durables -- on the assumption that the U.S. rate is also applicable to Canada. The benchmarks, replacement rates, and deflators are summarized in Table 7. Price indexes for each asset class for 1946-1973 are given in Table 8.

We assume that the real flow of services from each type of asset is proportional to its stock. To construct an aggregate quantity index of capital input we must weight each type of real service flow by its share in the total value of capital input. Thus we must construct a service price for each asset, which when multiplied times the corresponding stock yields the value of the service flow for each type of asset. We follow Christensen and Jorgenson (1969) in the specification of capital service prices. The specification of service prices requires explicit treatment of taxes. For tax purposes the Canadian private domestic sector can be divided into business enterprises and households. The household sector is not subject to direct taxes on the capital service flow from its assets. Business enterprises however, are subject to such direct taxation. In order to take

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[7] We divide replacement for each year by the stock at the end of the previous year to obtain annual replacement rates. We use the average of these annual rates as our replacement rates.

TABLE 7

BENCHMARKS, RATES OF REPLACEMENT, AND PRICE INDEXES EMPLOYED IN ESTIMATING CAPITAL

	Asset Class	1946 Benchmark (Millions of 1961 Dollars)	Replacement Rate	Deflator
1.	Consumer Durables	1,965	0.200	Implicit Deflator, NIEA*
2.	Non-residential structures	12,902	0.042	Implicit Deflator, NIEA
3.	Producer Durables	6,122	0.090	Implicit Deflator, NIEA
4.	Residential Structures	11,805	0.025	Implicit Deflator, NIEA
5.	Nonfarm Inventory	4,973	--	Investment: Implicit Deflator, NIEA Asset: wholesale price index industrial commodities
6.	Farm Inventories	2,510	--	Investment: Implicit Deflator; NIEA Asset: wholesale price index, farm products
7.	Land	30,794	--	Implicit Deflator; see text.

*NIEA refers to the National Income and Expenditure Accounts, Historical Revision 1926-73.

TABLE 8

ASSET PRICE INDEXES, 1946-1973

Year	Residential Structures	Machinery and Equipment	Nonfarm Inventory	Farm Inventory	Land	Residential Structures	Consumer Durables
1946	.586	.500	.666	.803	.289	.541	.638
1947	.654	.554	.700	.832	.330	.610	.729
1948	.731	.623	.829	1.005	.386	.715	.808
1949	.754	.663	.850	.990	.414	.745	.831
1950	.776	.700	.905	1.025	.453	.782	.850
1951	.877	.791	1.030	1.163	.528	.902	.959
1952	.928	.805	.969	1.084	.570	.918	.980
1953	.936	.820	.946	.960	.613	.926	.972
1954	.923	.830	.930	.925	.633	.918	.964
1955	.947	.844	.938	.921	.684	.936	.919
1956	.995	.896	.967	.928	.758	.950	.929
1957	.993	.943	.975	.925	.815	.977	.975
1958	.989	.958	.976	.965	.863	.974	.993
1959	.995	.980	.988	.970	.910	.973	1.011
1960	1.004	.993	.990	.981	.957	.992	1.013
1961	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1962	1.004	1.033	1.029	1.043	1.038	.997	.995
1963	1.032	1.061	1.048	1.023	1.111	1.020	1.000
1964	1.061	1.104	1.052	1.008	1.210	1.061	.991
1965	1.118	1.147	1.073	1.082	1.346	1.122	.992
1966	1.186	1.185	1.112	1.150	1.504	1.196	1.001
1967	1.236	1.177	1.132	1.143	1.651	1.265	1.036
1968	1.248	1.176	1.157	1.128	1.751	1.278	1.062
1969	1.316	1.207	1.210	1.172	1.884	1.339	1.082
1970	1.384	1.264	1.228	1.171	2.012	1.369	1.114
1971	1.469	1.298	1.243	1.159	2.191	1.454	1.125
1972	1.562	1.324	1.330	1.291	2.407	1.570	1.143
1973	1.685	1.379	1.563	1.646	2.687	1.717	1.158

this difference into account, we must allocate the stock of residential structures and between households and business enterprises and create distinct service prices for each.

We allocate the stock of residential structures between households and business enterprises by assuming that the ratio of rent to stock is the same in each sector. We use owner-occupied imputed rent and total rent from the National Income and Expenditure Accounts to make this allocation. We estimate that the proportion of the value of owner-occupied residential real estate attributable to land is .25. The rest of our total land stock, is allocated to business enterprises.

The household sector is not subject to direct taxes on the capital service flow from its assets. Indirect taxation, however, is levied on the capital service flow in the form of property taxes. The capital service price for each asset in the household sector can be expressed as

$$q_{K,t} = q_{A,t-1}r_t + q_{A,t}\delta - \quad q_{A,t} - q_{A,t-1} \quad + q_{A,t}\tau_t,$$

where $q_{K,t}$ is the service price, $q_{A,t}$ is the asset price, r_t is the rate of return or cost of capital, δ is the rate of depreciation, and τ_t is the rate of property taxation.

We assume that the rate of return is the same for all household assets. We have an estimate of property compensation for household owned residential structures and land. Thus we can equate this property compensation to the capital service price of residential structures times the lagged stock of residential structures plus the capital service price of land times the lagged stock of land. This gives us an equation where the household rate of